CLAIMS

What is Claimed is:

1. A current monitoring and control circuit for monitoring current flow through a control winding, said monitoring and control circuit comprising:

a magnetic amplifier, said magnetic amplifier including a first gate winding and a second gate winding electrically coupled in series and responsive to an AC drive voltage, said magnetic amplifier further including a bias winding responsive to a variable bias potential, said bias winding and said first and second gate windings being magnetically coupled to the control winding, said magnetic amplifier providing a gate voltage; and

a feedback circuit, said feedback circuit being electrically coupled to the bias winding, said feedback circuit being responsive to a reference voltage and the gate voltage, said control circuit changing the bias potential in response to changes in the control current so that the gate voltage remains substantially constant at a fixed operating point, said bias voltage providing a bias current through the feedback circuit that provides an output voltage indicative of the direction and magnitude of the current flow through the control winding.

2. The control circuit according to claim 1 wherein the bias current in the feedback circuit increases or decreases relative to a zero control current to provide the direction of the control current.

3. The control circuit according to claim 1 wherein the control current and the

output voltage are substantially linear.

4. The control circuit according to claim 1 wherein the feedback circuit is stable at the fixed operating point when the gate voltage is substantially equal to the reference voltage.

5. The control circuit according to claim 1 wherein the feedback circuit includes a feedback amplifier having a first input and a second input, and an FET, wherein the first input of the feedback amplifier is responsive to the reference voltage and the second input of the feedback amplifier is responsive to the gate voltage from the magnetic amplifier, and wherein a gate terminal of the FET is responsive to an output of the feedback amplifier, a source terminal of the FET is responsive to the bias voltage and the drain terminal of the FET provides the output voltage across an output resistor.

6. The control circuit according to claim 1 further comprising a reset circuit, said reset circuit being coupled to the magnetic amplifier and the feedback circuit, said reset circuit resetting the feedback circuit if the feedback circuit operates on an improper slope of the output voltage in response to sudden changes in the direction of the control current, said reset circuit also resetting the feedback circuit if the magnetic amplifier goes out of its operating range.

7. The control circuit according to claim 6 wherein the reset circuit includes a

first comparator and a second comparator, said first comparator being responsive to a feedback signal from the feedback circuit and the reference voltage, and said second comparator being responsive to the gate voltage and the reference voltage.

8. The control circuit according to claim 1 further comprising an output circuit, said output circuit being responsive to the reference voltage and the bias current and removing a zero current offset provided by the fixed operating point.

9. The control circuit according to claim 1 wherein the output circuit includes a plurality of output amplifier stages each being responsive to the output voltage from the feedback circuit and the reference voltage, wherein a first output stage provides an output signal indicative of the magnitude of a positive current flow through the control winding, a second output amplifier stage provides an output signal indicative of the direction of the current in the control winding, and a third output amplifier stage provides an output signal indicative of the magnitude of a negative current flow through the control winding.

10. A current monitoring and control circuit for monitoring current flow through a control winding, said monitoring and control circuit comprising:

a magnetic amplifier, said magnetic amplifier including a first gate winding and a second gate winding electrically coupled in series and responsive to an AC drive voltage, said magnetic amplifier further including a bias winding responsive to a variable bias potential and a rectifier for rectifying the current flow to the first and second gate windings and providing a gate voltage, said bias winding and said first and second gate windings being magnetically coupled to the control winding;

a feedback circuit, said feedback circuit being electrically coupled to the bias winding and to the rectifier, said feedback amplifier including a first input and a second input, and an FET, wherein the first input of the feedback amplifier is responsive to a reference voltage and the second input of the feedback amplifier is responsive the gate voltage from the magnetic amplifier, and wherein a gate terminal of the FET is responsive to an output of the feedback amplifier, a source terminal of the FET is responsive to the bias voltage and the drain terminal of the FET provides an output voltage across an output resistor that is indicative of the direction and magnitude of the current flow through the control winding, said feedback circuit forcing the magnetic amplifier to operate at a fixed operating point determined by the reference voltage, said control circuit changing the bias potential in response to changes in the control current so that the gate voltage remains substantially constant at the fixed operating point; and

a reset circuit electrically coupled to the magnetic amplifier and the feedback circuit, said reset circuit resetting the feedback circuit if the feedback circuit operates on an improper slope of the output voltage in response to sudden changes in the direction of the control circuit, said reset circuit also resetting the feedback circuit if the magnetic amplifier goes out of its operating range.

11. The control circuit according to claim 10 wherein the reset circuit includes a first comparator and a second comparator, said first comparator being responsive to a feedback signal from the feedback circuit and the reference voltage, and said second

comparator being responsive to the gate voltage and the reference voltage.

12. The control circuit according to claim 11 wherein an output of the first comparator is coupled to the second input of the feedback amplifier.

13. The control circuit according to claim 11 wherein the first comparator and the feedback amplifier are electrically coupled in a cross-strap configuration.

14. The control circuit according to claim 10 further comprising an output circuit, said output circuit being responsive to the reference voltage and the bias current and removing a zero current offset provided by the fixed operating point.

15. The control circuit according to claim 10 wherein the output circuit includes a plurality of output amplifier stages each being responsive to the output voltage from the feedback circuit and the reference voltage, wherein a first output stage provides an output signal indicative of the magnitude of a positive current flow through the control winding, a second output amplifier stage provides an output signal indicative of the direction of the current in the control winding, and a third output amplifier stage provides an output signal indicative of the magnitude of a negative current flow through the control winding.

16. A current monitoring and control circuit for monitoring current flow through a control winding, said monitoring and control circuit comprising:

a magnetic amplifier, said magnetic amplifier including a first gate winding and a second gate winding electrically coupled in series and responsive to an AC drive voltage, said magnetic amplifier further including a bias winding responsive to a variable bias potential and a rectifier for rectifying the current flow to the first and second gate windings and providing a gate voltage, said bias winding and said first and second gate windings being magnetically coupled to the control winding;

a feedback circuit, said feedback circuit being electrically coupled to the bias winding and to the rectifier, said feedback circuit being responsive to a reference voltage and the gate voltage, said control circuit changing the bias potential in response to changes in the control current so that the gate voltage remains substantially constant at a fixed operating point, said bias voltage providing a bias current through the feedback circuit that provides an output voltage indicative of the direction and magnitude of the current flow through the control winding, said feedback circuit forcing the magnetic amplifier to operate at the fixed operating point determined by the reference voltage;

a reset circuit electrically coupled to the magnetic amplifier and the feedback circuit, said reset circuit resetting the feedback circuit if the feedback circuit operates on an improper slope of the output voltage in response to sudden changes in the direction of the control circuit and resetting the feedback circuit if the magnetic amplifier goes out of its operating range; and

a plurality of output stages responsive to the output voltage from the feedback circuit and the reference voltage, said output stages providing a magnitude of the control current, a direction of the control current and removing a zero current offset provided by the fixed operating point.

17. The control circuit according to claim 16 wherein the feedback circuit includes a feedback amplifier having a first input and a second input, and an FET, wherein the first input of the feedback amplifier is responsive to the reference voltage and the second input of the feedback amplifier is responsive to the gate voltage from the magnetic amplifier, and wherein a gate terminal of the FET is responsive to an output of the feedback amplifier, a source terminal of the FET is responsive to the bias voltage and the drain terminal of the FET provides the output voltage across an output resistor.

18. The control circuit according to claim 16 wherein the reset circuit includes a first comparator and a second comparator, said first comparator being responsive to a feedback signal from the feedback circuit and the reference voltage, and said second comparator being responsive to the gate voltage and the reference voltage.

19. The control circuit according to claim 16 wherein the plurality of output amplifier stages are responsive to the output voltage from the feedback circuit and the reference voltage, wherein a first output stage provides an output signal indicative of the magnitude of a positive current flow through the control winding, a second output amplifier stage provides an output signal indicative of the direction of the current in the control winding, and a third output amplifier stage provides an output signal indicative of the magnitude of a negative current flow through the control winding.